ANTISEPTIC PRINCIPLES
FOR
NURSES

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ANTISEPTIC PRINCIPLES

FOR

NURSES

BY

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PREFACE

In the course of extensive hospital experience, the observation has forced itself upon me that whilst nurses mostly receive careful instruction in the "technique" of antiseptic dressings, and are fairly familiar with the substances used, and the routine of the application thereof, they generally lack an insight into the scientific principles which dictate the selection of these substances and the intelligent use of the same. In my short lectures to nurses, therefore, it seemed to me more useful to direct my efforts towards elucidating these principles as simply and concisely as I could, rather than to enumerating and classifying antiseptic substances and methods with which they will in the ordinary course of their training become well acquainted.

It will, I think, be conceded that considerable difficulties must attend an effort to array abstruse scientific facts in a manner to be "understanded of the people." But the hospital nurse of to-day is of superior intelligence and education, and will, I trust, have little difficulty in following my humble efforts in that direction. I have been obliged to assume that she has received *some* elementary instruction in anatomy and physiology. At almost all hospitals such instruction is now within the reach of every nurse by means of lectures delivered to them, and without it none can obtain a competent "grip" of their professional duties.

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SCHEMA

I. Dressing of Wounds.
   Aspect of Healthy and Unhealthy Wounds.
   Putrefaction.
   Explanation of Terms "Septic," &c.
   Connection between Sepsis and Germs.

II. Germs: their Life-history and Action in producing Disease.
   Self-protective Action of Bodily Tissues (Phagocytosis).
   "Immunity."
   Some Germs of Special Disease.

III. Asepsis and Antisepsis practically considered.

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ANTISEPTIC PRINCIPLES FOR NURSES

CHAPTER I

The routine and practice of antiseptic dressings is always under the observation, and is part of the daily duties of hospital nurses. They know the different substances used, and their mode of application, and observe the great precautions (to which I shall immediately allude) adopted in connection with the dressings of operation wounds. Many nurses, however, do not understand *why* these precautions are adopted, nor what reasons have led to their use; yet without this knowledge they carry out the details with a fair amount of accuracy, even though lacking an intelligent appreciation of their origin. Still it must be evident that an insight into the principles which dictate these precautions will enhance the value of nursing aid in all such procedures.

To amplify somewhat, and to address myself directly to nurses:

Suppose you are on accident ward duty. A patient is brought in with, say, a wound of the arm. What generally occurs? The wound is carefully washed with some so-called antiseptic solution (often carbolic acid or perchloride of mercury), all bleeding is arrested, and clots cleared away. Again the wound is washed with antiseptic, and, if necessary, sutures are applied. The skin around the wound is carefully cleaned, and then dressings of a more or less elaborate nature are applied and fixed in position with a bandage.

Not very many years ago such a wound would have been treated as follows:—After the arrest of bleeding it would have been sluiced out with cold water, a piece of wet lint applied over it, possibly covered by a bit of gutta-percha tissue, and a bandage applied over all. Why are we so much more careful now-a-days? You will learn later.

Again, you have noticed the precautions now adopted in connection with a surgical operation. The region where the incision will be made is carefully washed and scrubbed, turpentine or spirits of wine being used to remove all greasy dirt, and for some time before the operation the part is packed round with cloths soaked in some so-called antiseptic solution. The instruments to be used are subjected to a considerable heat, either by immersion in boiling water, or by "baking" in a specially constructed oven (a "steriliser"), and then placed in antiseptic solution until required for use. The dressings for the wound are also often subjected to heat in the steriliser. All persons engaged in the operation scrupulously clean their hands and nails, and both before and during the operation repeatedly plunge them in antiseptic solutions. No finger is allowed to touch the wound or dressings that has not been so treated. During the continuation of the operation the wound is frequently "flushed" or "swabbed" with like solutions. On its completion every particle of blood-clot is cleared away, drainage-tubes if necessary are adjusted, and the whole covered up with ample dressings. The subsequent course of the treatment of the wound we shall directly touch upon, as it is intimately connected with our subject. Here, again, I may remark that the reasons for these very careful proceedings will be apparent to you subsequently. For the present, however, it will seem to you that elaborate *cleanliness* is sought in the dressing of wounds. This is rigidly true. It is not merely cleanliness which meets the eye, but cleanliness which will satisfy the most inquisitive search of the microscope.

Now it is very important to inquire somewhat into the after-history of these wounds, which varies very much. In one case, perhaps, the patient will remain quiet and comfortable, the temperature keeping near the normal, the pulse firm and not too rapid, the tongue clean, and the bowels acting well, and the part around the wound free from offensive odour. Under these circumstances you know from experience that the patient is doing well, healing is proceeding naturally, and the less the wound is disturbed the better. Therefore the dressings may be left undisturbed for days or even weeks. If such a wound be inspected during healing it will be found often in the following condition:—The sides of it, or the "flaps," have adhered firmly together without inflammatory redness. There is very little (perhaps almost none) of clear inodorous discharge. The result is a clear, firm scar with level pinkish edges. These appearances, roughly speaking, are typical of a healthy wound, and are described as "healing by first intention," which, where possible, it is the aim of all surgeons to secure.

But other cases have passed under your experience very different from the foregoing. The temperature rises, the pulse increases in rapidity, disturbances of the stomach and bowels set in, accompanied by pain and uneasiness to the patient. These are all indications that something is going wrong, and the wound, of course, is inspected without delay. It is then often seen that its edges are puffed and swollen, angry red in colour, gaping apart, and with foul, dirty-looking pus welling up from between them. This state of things differs very markedly from that just described, and is characteristic of an *unhealthy* wound.

Now why should these differences exist? There must in the second case be some influence at work which was not present in the first. This "influence" has been carefully investigated by many observers in many countries; and the result of their investigations is the establishment of the fact that the morbid processes in unhealthy wounds are due to the presence in them of very minute organisms. To these, whose nature we shall presently have to investigate, I shall have to direct your close attention. The complete consideration of the morbid influences acting on wounds, or their 'pathology," as it is called, involves matters we cannot enter into in these elementary studies, but a short survey of these organisms, or *germs*, as they are termed (and their action in disease), is essential to our studies.

We must, however, for a moment consider the condition of wounds yet further. A prominent feature in unhealthy wounds is the presence of dead stinking pieces of tissue, or "sloughs." These are the result of *putrefaction*. Strictly speaking, putrefaction means the changes which go on in *dead tissue* when exposed long enough to the air (*i. e.* to the germs it contains). The Greek word for putrefaction was "sepsis," from which we derive our terms septic, aseptic, and antiseptic. Thus *septic* implies the presence of putrefaction, *aseptic* the absence of it (and the germs producing it), and *antiseptic* conditions adverse to, or combating these germs.

But even in dead tissue, if we can protect it from germ attack, no putrefaction will take place. These germs flourish only within certain limits of temperature. They are inactive at low temperatures (freezing-point), so that dead tissue can be preserved indefinitely from putrefaction if kept at a low temperature. Thus it is that the carcase of an animal slaughtered in Australia, New Zealand, or South America can be delivered in England many weeks afterwards in a sweet and wholesome condition for human food. Heat also (the temperature of boiling water) is fatal to germs of putrefaction. A familiar instance of this is seen in the domestic "stock-pot" for soups, &c. Here you have an albuminous solution or jelly which under ordinary conditions would prove a most fertile soil for germ development. If, however, this solution is every now and then heated to the boiling-point, it will (as every cook knows) keep sweet and palatable for a very considerable time.

But as to the connection of putrefaction with wounds; for this to take place it is not necessary that the *whole animal* should be dead. During the infliction of some wounds (badly contused or lacerated, for instance) the parts or tissues around may receive such injuries as to *kill* them, although they still remain attached to living parts. These dead parts, if not protected by artificial means, will just as assuredly become putrid as will a piece of meat exposed to the air. If, however, proper precautions are adopted, the wound can be kept sweet and clean even though dead tissue be present in it.

We cannot, however, in these short studies confine ourselves to changes which occur in dead tissue only. These are perhaps the most prominent and self-evident changes which may occur in the history of a wound. There are processes, however (termed *inflammatory* and *infective*), which, without being distinctly connected with dead tissues, yet play a very important part in the production of unhealthy wounds. These are equally the result of germ invasion, and may merely affect the wound itself, or by extension or absorption affect the general bodily system, and produce grave and even fatal disturbances thereof. Erysipelas and tetanus are instances of this latter condition.

Thus we may be allowed, perhaps, to consider a septic wound as one which not merely contains putrid tissue, but as one which departs from the normal processes of healthy healing.

We have already considered the appearances of "healing by first intention." Even in healthy wounds this cannot always be obtained from the circumstances of the wound itself; as, for example, where a large amount of tissue has to be removed, and the wound, instead of its sides coming together as "flaps," has to be left for the processes of repair to fill up the gap. Here, however, if the wound be healthy, you will see a clean-looking, "granulating" surface throwing off small quantities of healthy inodorous pus, the edges being firm and level.

Of course, I have only described prominent types of wound healing; many others exist which we cannot consider here, but the main features of healthy and unhealthy wounds are now before you.

We can now conveniently revert to the causes which affect these differences in the aspect of different wounds. These, as I have said, are due to the presence of *germs* (or microbes, or micro-organisms, as they are frequently termed).

Now how is this proved? As follows:—In septic wounds certain germs or their products are always abundantly present, and can easily be detected, whilst in aseptic wounds they are scanty or absent. Again, if these germs found in septic wounds be inoculated into other individuals it is possible to produce wounds (and diseases) identical in character with those from which the germs were procured. In former times, and not very long ago, an instance of this used frequently to occur in hospital wards where, if erysipelas attacked one patient almost every other patient (with a wound) in the same ward (and often in many others from the infection conveyed by nurses) would be attacked by the same disease. The precautions, however, that antiseptic principles have led us to adopt have almost entirely eliminated these regrettable infections.

It is beyond our limits to array full proofs before you, but I must ask you to take it as a thoroughly established fact that all septic conditions in wounds are due to the presence of germs of some kind; and that where the invasion of these, either from within or without, is prevented, sepsis is absent, and healthy healing is the rule.

We are now, I think, in a position to pass on to the more special consideration of the germs themselves, to which I have so often alluded.

CHAPTER II

We may, perhaps, best consider germs under the following headings:

1. Their nature and distribution.
2. Appearance and mode of growth.
3. Conditions of life and development.
4. Action in producing disease.
5. Some germs of special diseases.

Nature and Distribution

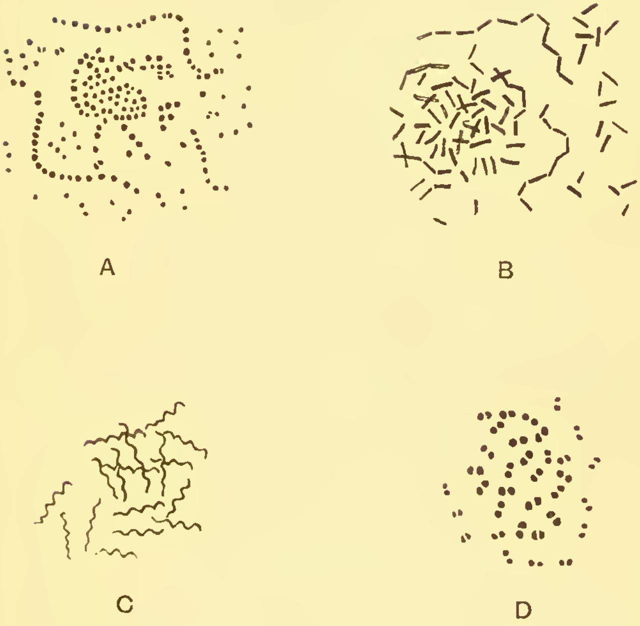
These minute organisms have been classified as belonging to the smallest and most elementary forms of vegetable life; they are *plants,* but of the tiniest and simplest nature. They have no leaf or stem, and consist of minute particles of albuminoid matter apparently devoid of any arrangement into different organs, &c. They belong to the group of vegetables termed Fungi. They assume many varied forms and sizes. Their modes of development and reproduction would seem to indicate that they possess a structure more complex than has yet been discovered or described. To detect even the presence of some of them the higher powers of the microscope are necessary, so that it is not likely with the means now at our command any minute details of their organisation can be forthcoming. As regards the distribution of germs there is no need to say much. They are present in everything around us,—in earth, air, and water. We eat them, drink them, and breathe them in every moment of our lives. They are present in our food, on our skins, in our "insides," in the clothes we wear, the beds we sleep on, and the very soap and water we wash with. Many of them are innocent of any share in causing disease, and the presence of some of them is even necessary for the performance of certain bodily functions (digestion, for instance). With these last we have no immediate concern. Some germs, however, have been incontestably proved to be connected with various diseases and with unhealthy processes in wounds, and some few of these we shall consider later. It is not necessary to mention in detail the habitat of each particular germ, though some of them have special "breeding-places," if we may use the term. Thus the germ of tetanus resides chiefly in the earth, and hence it was that the ravages of this disease were often manifested in the injured after a battle, where they lay on the ground for hours with undressed wounds. In civil practice, too, this disease is mostly met with where wounds have been impregnated with dirty soil, or where the patient has been exposed on the ground for a considerable time.

Appearances and Mode of Growth

Germs vary much in size, shape, and appearance. Some appear to be minute spheres or "dots," termed "micrococci;" some are rod-shaped, straight, or may be curved (bacilli and bacteria). Some are wavy filaments (spirilli). They may be seen, perhaps, scattered throughout the field of view, devoid of any particular arrangement whatever. Again, they may be arranged in pairs, or in long strings or "chains," or crowded together in vast numbers to form a "colony."

Their modes of growth and multiplication are very simple. One mode consists of a constriction along the middle of each organism, which, gradually deepening, ends in its separation into halves, each half becoming a separate organism. Such growth, if continued indiscriminately in all directions, will lead to the formation of masses or colonies such as I have mentioned. Sometimes, however, this growth continues only along one line, and the new germs remain united together, and then we get the strings or chains. This process of division progresses with enormous rapidity. A single germ will have completed it in not very many minutes, and as each half proceeds to divide immediately in the same manner the speed of multiplication is hardly credible. Thus it has been calculated (Cohn) that in twenty-four hours a single bacterium may produce a progeny of *sixteen millions.*

Another method is by means of *spores.* Small rounded spots or bodies appear in the germ, which are called spores. The parent germ itself breaks up and liberates these, each one of which becomes a new organism and repeats the process in its own person. Both methods of reproduction are easily seen in the *Bacillus anthracis* (the germ of malignant pustule and "wool-sorter's disease"), which is one of the largest and hardiest of these germs. These particulars as to appearances, mode of growth, and reproduction will seldom come within the scope of a nurse's work, but they may be mentioned as necessary for the identification of special germs in connection with various diseases.



A. Micrococci arranged in chains, or scattered about, or aggregated into a colony.

B. Bacilli, or bacteria, showing similar arrangement.

C. Spirilli.

D. Arrangement of micrococci in pairs ("diplococci").

Conditions of Life and Development

As is the case with all living organisms, germs are affected by external conditions, such as temperature, moisture, &c., which are either favorable or unfavorable to their growth. We may perhaps arbitrarily classify these conditions under four headings:

1. *Absolutely adverse*, where the germ will more or less speedily perish.

2. *Adverse, but to a less degree.*—Here the germ, without being directly killed, yet cannot largely multiply nor exhibit the special qualities associated with it (to which we shall subsequently allude). It may, however, retain its vitality—especially in the spore stages—for an indefinite period, ready to burst into activity the moment it encounters conditions more favorable to its growth.

3. *Slightly favorable.*—Here the multiplication of the germ is sluggish, and its special qualities feebly manifested; yet, as in the preceding case, they will readily be called into action under favorable circumstances.

4. *Favorable conditions.* — Here reproduction proceeds with the great rapidity already men-

tioned, and the special qualities of the germ (in disease virulent ones) attain full play.

The bearing of the foregoing will become more manifest when we discuss the action of germs in producing disease.

Generally and roughly speaking, the conditions favorable to the growth of germs affecting wounds are—

A. A temperature approximating that of the human body. [*Note.*—The range of temperature for possible existence of *all* disease germs is not very great, and is, generally speaking, well within the freezing and boiling points. The special range for each particular germ is of course much less than these limits, which are only approached by the most hardy germs (*e.g. Bacillus anthracis*).]

B. Presence of a certain amount of moisture. Absolute dryness kills or renders dormant most germs.

C. A restricted air-supply. A constantly renewed supply of pure air is unfavorable to the growth of many germs. Oxygen gas forms a large part of the air we breathe. Exposure to this gas in its pure unmixed form is fatal to most of them.

D. Absence of light. Bright sunlight is most unfavorable to the growth of germs.

E. A suitable soil in which to increase and multiply. This "soil," in the case of wounds, is supplied by the injured parts or tissues, and especially by the serum which drains away from them. In these they develop rapidly. When the soil is exhausted, germ growth of course ceases.

The conditions of an imperfectly dressed wound will, as you may infer, secure almost every one of the foregoing favorable circumstances. Thus you have the warmth, moisture, restricted supply of air and light, and the soil for growth.

The adverse conditions are of course the converse of the preceding, and have been alluded to in their enumeration. We may, however, emphasise by repetition, and say that germ growth is checked or prevented by—

A temperature sufficiently high or low.

Restriction of amount of moisture to as near dryness as possible.

A supply of air more abundant or more restricted than (most) germs can live in.

Protection or alteration of the soil in which they breed. (This may be effected by certain chemical substances adverse or fatal to germ growth, which are termed antiseptics.)

(The admission of bright sunlight, in constant supply, into the treatment of wounds is not a factor which we can regard as practicable.)

I may, perhaps, at this point introduce a few remarks as to the circumstances attending a wound, which will explain to you how and where the soil for germ development is obtained in it. The presence of a wound implies several conditions, which we will consider separately. These are—

1. A gap in the continuity of the tissues, or their severance from each other. Thus instead of an even continuous *skin* surface, which resists the passage of germs; the muscles, vessels, and fasciæ are opened up to their passage with the influx of air. We may, as a practical point, note here the protective barrier afforded by healthy skin. You have often seen contusions of the limbs and body where the parts are "black and blue." If you could see beneath the skin, you would find the deeper parts torn, crushed, and gorged with effused blood. As long, however, as the *skin* remains unbroken these injuries will be repaired gradually, without any sloughing or suppuration. But let this protecting barrier of skin once be destroyed, and the entrance of germs secured, and there will often be, as you well know, troublesome and prolonged sloughing and suppuration. This pro-

tective influence of the unbroken skin was a fundamental principle with surgeons long before the introduction of systematic antiseptic surgery by Lord Lister.

2. The severing of the tissues in a wound divides many blood-vessels—small, or it may be large. These for a certain time pour out blood which solidifies in the wound as "clot." Even when this is removed, and general bleeding has ceased, there still drains away a large amount of "serum" (the fluid portions of the blood), which covers all the surfaces of the wound. This serum is, above all other materials, the soil in which disease germs find the most favorable conditions for their development in and about wounds.

3. Besides the blood-vessels opened up in a wound, there are the lymphatic vessels and spaces. These most readily collect and convey into the general system any poisonous products (and in some cases the actual germs themselves) which may be present in the wound as the result of germ action.

From the above you will see that a wound offers a ready channel for the attack of germs, and supplies them with conditions favorable to their development. This will at once suggest to you the necessity for protecting it from their attacks by artificial means.

Action of Germs in producing Disease

As you will have gathered from the foregoing, a germ has only to fall into a soil suitable for its development to exhibit its enormous rapidity of multiplication. In this word "soil" we may conveniently include both a suitable material for it to grow in, and also favorable conditions as to temperature, moisture, &c. We will now consider the morbid action of germs—not in wounds only, but in general bodily diseases.

Under ordinary circumstances the tissues of the body offer great resistance to the attack of germs; but very slight change (chemical or physical) in the conditions of a part may lay it open to such attack. Any departure from normal health may render a person liable to attacks of certain diseases from which he would otherwise be free. Possibly this is what happens in an ordinary "cold in the head" and its sequels. Here exposure to cold or damp may reduce the system to a condition favorable to the attack of germs which flourish in the mucous membrane of the nose and air-passages, and there set up the irritation and inflammation characteristic of these disorders.

The action of a germ in producing disease, either locally in a wound, or generally in infection of the whole body, probably follows one or all of the following channels:

1. The accumulation of germs in the tissues and vessels constitutes a mechanical obstacle to the performance of their various functions—actually in a sense *choking* them. In addition to this mechanical obstruction they may also in their growth abstract the oxygen (from the blood) necessary for the nourishment of the tissues, giving off instead carbonic acid gas, which acts as a direct poison to them.

2. The germ itself constitutes a sort of poison to the tissues, entering into direct combat with their cellular elements.

3. In the growth of germs there are manufactured and liberated certain poisons which have a deleterious effect either at the site of their growth, or on the general bodily system after absorption into it.

Besides the action of the germs themselves, it will here be useful to consider the part played by the small elements of the bodily tissues. These are not by any means passive victims to germ ravages; they fight, and vigorously too, in health. All wounds, even the merest scratches, are exposed to germ attack; yet, as you well know, the vast majority of small wounds are unattended by any serious consequences. Large wounds, however, present a more extensive field for germ cultures; and in their infliction the tissues are more extensively damaged, and therefore less capable of resistance to them. Hence large wounds are oftener followed by hurtful sequels than are small ones. Even a small wound, however, may under special circumstances be the channel for the introduction of a large or concentrated dose of germ poison, and be followed by alarming consequences.

But to consider the action of the tissue elements. By means of the microscope it can be often seen that germs which have lodged in these cells dwindle away and disappear, the cells themselves appearing none the worse for the encounter. This property of demolishing germs (phagocytosis, as it is termed) belongs peculiarly to the cells termed "leucocytes;" and whilst it is sufficiently active a wound will remain free from the grosser results of germ attack. If, on the other hand, the germ attack is numerous and powerful enough to overcome the resistance of the tissue elements, then these latter perish, wound infection follows, the wound becomes fouled, and possibly grave constitutional mischief ensues. This resistance of the tissues to germ infection—a kind of *natural antisepsis*—is a most important factor in healing. It varies very greatly in different individuals, and also in the same individual at different times. Some people, for instance, are very liable to have the smallest scratch followed by tiresome inflammation and suppuration, whilst others bear all injuries remarkably well. These last will tell you that they have "good healing flesh." Some, again, appear to be attacked by every disease that is epidemic, whilst others seem to have complete freedom from them even though exposed to precisely the same circumstances for infection. In the former case the resistance offered is at the minimum, and the unfortunate patient suffers from the attacks of many germs which others easily resist. This resistance to infection constitutes the so-called *immunity* from special disease, whilst the proneness to it is termed an idiosyncrasy for special types of disease. The same individual may exhibit both immunity from some disease (say scarlatina, for instance), and idiosyncrasy for others (say measles and influenza), according to the nature of the "soil" he presents in each case.

Generally speaking, one attack of a "fever" disease leaves the patient largely immune to subsequent ones, in that during it the soil for the development of that special germ is so consumed or altered as to render it barren (at any rate for some time), for the future cultivation of the same germ.

We may here point out that external circumstances (such as temperature, moisture, air-supply, and medium in which growth takes place) not only influence the activity and reproduction of the germ, but also in a marked degree influence its special qualities and the processes to which it gives rise. In some cases these external circumstances may foster and increase the virulent properties of a germ, and in others diminish them. Thus by modifications of its surroundings we may render a *vicious* germ *innocent*, and *vice versâ*. The study of conditions which will modify the baneful qualities of a germ without actually destroying it or checking its growth forms a most important branch of "preventive medicine" as concerned in the now widely practised "protective inoculations." These, though only a development of recent years, are daily growing more important in the treatment of disease. The germs whose vicious qualities have been so modified by treatment as to render them inert, or *sterilised* germs; as they may be termed, will attack the same parts or tissues as would the unaltered or virulent germs. In doing so, however, they consume the *soil* on which the virulent germs would live, and thus protect the body from their attacks.

This is very roughly and briefly only an account of one phase of germ history which has given rise to the various *toxins* and *antitoxins*, as they are called, which are the products of these artificially cultivated germs. It will be seen, however, that these are the outcome of antiseptic researches, and form an essential part of such principles.

Some Germs of Special Disease

This subject is far too extensive for more than the most passing notice, nor can it be said to come within our scope, but a few words concerning the germs of one or two of the commoner types of disease will be useful as illustrating their action, and the means taken to combat it.

Now various germs find in different parts of the body the different soils they select for their growth, and hence their effects are manifested by varying symptoms in each case according to the organ or part attacked. Thus the germ of erysipelas flourishes chiefly in the lymphatic vessels; that of splenic fever in blood that is circulating, that of tubercle in blood that is stagnant; that of enteric fever and cholera in the mucous membranes of the intestines. Certain germs or their resultant products show a proneness to attack portions of the nervous system presiding over vital functions, viz. of respiration or circulation, in a manner similar to that of some direct chemical and vegetable poisons. This attack perhaps paralyses these nervous centres and suppresses their functions, and speedy death of course results. This action is illustrated in some snake poisons, and in those of tetanus and hydrophobia

In many cases a particular disease can be shown to be associated with a particular germ, because, as we have seen, this germ is always present at some time during the disease; and also by inoculation with it the same disease can be reproduced in another individual. We have not space to illustrate all the diseases which have been identified with the presence of special germs, but we may consider very shortly, say, three of the commoner types of morbid processes which daily pass under your notice.

We will select suppuration, putrefaction, and tubercular disease.

Suppuration.—In suppurations or discharge of "matter" from wounds several kinds of minute spherical organisms (micrococci) are concerned, the most important and prevalent one being named the "*Micrococcus pyogenes-aureus.*" This organism exists in many media around us. It is present on the skins of most people (especially amongst dirty individuals), ever ready to infect a wound. I need hardly remind you that suppuration in wounds is far more frequent in dirty people than in clean, nor point out the necessity for thoroughly cleansing the skin around all wounds as a simple precaution to be adopted in all cases. The above-named germ can be obtained from any suppurating wound, and by inoculation produce suppurating wounds elsewhere.

Putrefaction, or decay, or rottenness in dead tissue, is due to the presence in it of certain rod-shaped organisms (bacteria). These in their growth give rise to chemical changes which alter the tissues in appearance, in consistence, and in odour, rendering them dirty-looking, softened, and stinking. In the progress of these changes, and especially in their earlier stages, are often manufactured certain very virulent poisons (termed ptomaines), which if accidentally inoculated or absorbed may produce the gravest consequences. An instance of this is seen in the so-called " blood-poisoning " resulting from post-mortem examination of the body. We have earlier on alluded to putrefaction, and pointed out that if the germs thereof be excluded, dead tissue (either in a wound or in a carcase) can be kept sweet and clean.

Tubercle.—This widely distributed disease may come under your notice as pulmonary consumption (where the lungs are affected), as bone or joint disease, or as disease of any organ or tissue of the body. In the so-called " scrofula " the skin and lymphatic glands are chiefly affected, giving rise to those unhealthy-looking ulcerations and suppurations you have so often seen. The greater part of the chronic bone and joint affections you see in the wards are of a tubercular nature. " Water on the brain " (hydrocephalus, or tubercular meningitis) is due to a tubercular infection of the " meninges " or coverings of the brain. All these conditions are due to the presence of an extremely minute rod-shaped organism, the *Bacillus tuberculosis.* The lodgment of this bacillus at any one spot gives rise to chronic inflammation there, and to the formation of a small nodule or *tubercle* (hence the name of the disease). We cannot discuss the complete after-history of this tubercle, but may remark that it often breaks down, leading to the ulcerations and suppurations characteristic of the disease, which according to their localisation in different parts produce more or less important symptoms. Thus tubercle in the skin only may be productive of nothing but simple discomfort; tubercle in the brain will cause the direst consequences. From the deposit of even the smallest focus of tubercle in any part, the whole system may be more or less rapidly infected, and this is the reason why very grave operations are often undertaken for the removal of tubercular glands, —as, for instance, those deeply seated in the neck, and surrounded by structures of vital importance. The presence of the germ in tubercular lesions, and the possibility of producing similar lesions by its inoculation elsewhere, have been proved "up to the hilt."

These three familiar instances will, I think, be sufficient for our purpose, and we may now turn to the practical application of our germ studies.

CHAPTER III

Practical asepsis and antisepsis.—Having considered the history and action of germs, we can now consider the means taken to combat them. The whole treatment of wounds, at any rate in their earlier stages, resolves itself into two procedures of which we have already spoken, viz.:

1. An endeavour to exclude germs as far as possible (asepsis).
2. An endeavour to kill or render harmless such germs as may be present under any circumstances (antisepsis).

Asepsis.—The ordinary routine of toilet of wounds (with which we opened our subject) varies much under different circumstances, and with the individual caprice of the surgeon, but the main objects of all wound treatment are to secure the two above principles.

Bearing in mind the presence of germs in everything around us (and often even in the very antiseptic dressings we use), you can see that it is practically impossible to *entirely* exclude them from a wound, especially in the first instance, though we may do much to exclude their entrance subsequently. One of the simplest methods of doing so is by filtering the air around the part we wish to protect. It has been experimentally proved that air which has been passed through some layers of fine cotton wool is to a large extent free from germs, most of which are arrested by the fine filamentous fibres of the cotton. This fact we often make practical use of by covering and surrounding a wound with a good thickness of cotton wool, thus preventing the access of germs. One precaution in applying filtering material over a wound is frequently neglected, and that is the shutting off the access of air between the filtering material and the skin. With the most careful bandaging, even with elastic bandages, the movements of the patient are liable to displace the dressings and admit *some* air. This, however, is very easily prevented by sealing the edges of the filtering material to the skin by means of tincture of benzoin, which is easy of application, not irritating to the skin, and fairly antiseptic as regards germs.

Besides excluding germs from a wound after its infliction we endeavour (in the case of operation wounds) to exclude them both before and during the operation. With this end in view, we "sterilise" all things which will come into the neighbourhood of the wound, *i.e.* place them under conditions which will destroy the germs present in or on them. Thus we adopt the elaborate precaution described at the very outset. The sterilising of instruments and dressings is very easily accomplished by submitting them to a temperature higher than that at which germ life is possible. Some surgeons, especially in Germany, have gone yet further. They have even attempted to sterilise every one who is present during the operation by means of antiseptic baths and changing into sterilised clothes before entering the operation room; where also the air has been sterilised. They cannot sterilise the breath of every one present (or they *would*). It cannot, however, I think be maintained that these intensely elaborate precautions have secured results greatly superior to those attending the intelligent application of ordinary aseptic and antiseptic principles. These rightly applied will generally secure the presence of such a small dose of germs that the bodily tissues will readily account for such as may be left in spite of all our care. Thus the aim of aseptic surgery is to remove all sources of contamination, and to allow the wound to heal by the simplest natural processes.

After completion of the dressings following immediately on the operation, we may leave the wound untouched for days or even weeks, unless the temperature or condition of the patient indicates that something has gone wrong.

Antisepsis of late years has been used more as an adjunct to asepsis than as a special procedure of its own, though really the forerunner and introducer of the latter. I need only quote the old proverb that " prevention is better than cure " to illustrate the value of the two treatments. We almost invariably, however, find it necessary to combine the two procedures. Thus by sterilising and filtering (asepsis) we exclude germs; by the douching, &c., during operations, and the substances applied to the wound, we kill such as are present already (antisepsis).

Now we cannot apply to a wound the simplest means of killing germs, that is by a temperature sufficiently high or sufficiently low, because this would be hurtful to the tissues themselves, and interfere with the processes of healing. Therefore we resort to other means. We apply chemical substances which are fatal to germ growth, and whilst doing so endeavour to secure those which are least irritating to the wound surfaces. The name of these substances is legion, and each month almost witnesses the introduction of some antiseptic of specially advertised virtues. You are acquainted with many of them, and very familiar with the commoner forms, such as carbolic acid, iodoform, perchloride of mercury, and the rest, both odourless and "pungent." They are much too numerous to consider in detail, especially as our object is to point out the reasons for their use as broad principles, and not to assess their respective values; the more so as opinions differ markedly on these points.

Although the *principle* of antisepsis receives universal recognition, some (or most) of the substances employed in it have been assailed on the ground that, despite their germ-killing properties, they are open to the following objections:

1. That when used in strength sufficient to be fatal to germs they may be irritating to the tissues, and so of themselves give rise to inflammatory disturbances which interfere with healing.

2. They may at times be absorbed into the general system in poisonous doses, and give rise to severe constitutional disturbances.

3. When used in a less concentrated form their germicidal action is only very temporary, the antiseptics themselves becoming so altered in composition that they may even become the vehicles for transmission of germs. Some, again, may be speedily volatilised (converted into vapour or gas) by the bodily heat, and so be dissipated, and have only very temporary antiseptic qualities.

All these objections are to a certain extent valid; and iodoform, carbolic acid, perchloride of mercury, permanganate of potash, and eucalyptus, for instance, are each of them open to one or all of these drawbacks. With ordinary precautions, however, such objections are minimised, and these substances, intelligently applied and renewed according to the requirements of each case, afford very efficient protection against germ onslaught.

As I have before said, it is not expedient to discuss the very many different substances used, but there is one *type* of dressing we may mention as being both theoretically and practically of great value. I allude to substances which combine the "filtering" (aseptic) action with the "germicidal" (antiseptic) properties. Instances of such substances are seen in "wood-wool" and "sal-alembroth" wool, and their various "gauzes" and "tissues." The aim of these dressings is to filter the air (generally with an accessory layer of absorbent wool outside them), and to sterilise any discharges which may flow from the wound into them by means of the chemical substances with which they are impregnated.

Action of Oxygen

The air we breathe consists almost entirely of two gases—oxygen and nitrogen. Of these oxygen plays by far the more important part in the functions of life. Its presence in the blood is necessary for the discharge of the function of respiration, or aëration of the blood, which takes place in the lungs. Nitrogen we may roughly say (although serving other important uses in the animal economy) serves to dilute the oxygen, which, if inhaled for any length of time in its pure state, would irritate the lungs.

Now pure (undiluted) oxygen has been found to be fatal to very many germs, whilst at the same time it does not irritate the surfaces of a wound. This has led to an endeavour to secure its production *in the wound itself* by using such substances as boracic acid, manganese dioxide (known in a familiar form as "Condy's fluid"), and eucalyptus (though this possesses other antiseptic attributes), which under certain conditions liberate oxygen gas. Now *if* the supply of oxygen from these was sufficiently regular and constant, they would be ideal antiseptics, in that the germs would be rendered innocuous without irritating the wound. *But* the supply of oxygen from them is neither copious, regular, nor permanent, nor is it mostly practicable to secure its access to all parts of the wound. Hence these substances are not very reliable antiseptics, and have as at present used the disadvantage of needing frequent renewal as dressings.

[*Note.*—The action of the newly discovered constituent of the atmosphere, *argon*, with regard to germs (if any) has of necessity not yet been demonstrated.]

Before concluding we must at any rate notice one point of practical import, viz. the relative value of *dry* and *wet* dressings as applied to wounds. The latter are more and more retiring from use, and for solid reasons. Wet dressings soon acquire the temperature of the body, feel sodden and uncomfortable, and if the substance used is of a "volatile" nature (carbolic acid, eucalyptus, &c.) it is soon dissipated. They thus furnish some conditions favorable to germ growth, viz. warmth, moisture, and restricted air-supply;

and, again, labour under the disadvantage of needing frequent renewal. After the wound, then, has been thoroughly cleansed and disinfected, dry dressings are to be preferred as a rule, since these need far less frequent renewal, and therefore do not interfere with healing processes.

One special point, however, needs comment in connection with dry dressings. If the discharges from the wound (blood, serum, or pus), which may be copious, soak through the dressings and come in contact with the outer air, *then* there is immediately formed a channel for infection, because there is a moist, warm, good (albuminous) soil for germ transit and development. Hence immediately the discharges soak through the dressings and appear on the surface these must be changed. As I have before stated, however, under favorable circumstances dry dressings may be left unchanged for days or even weeks.

Another practical point needs mention, though it does not strictly come under an " antiseptic " heading. This is the treatment of wounds which are necessarily septic from their commencement, owing to the conditions under which they are inflicted and by which they are surrounded. For instance, burns and scalds furnish a large surface of injured tissue, which affords a fine field for growth of germs of putrefaction and suppuration. Again, we may consider cases of extravasation of urine into the fasciæ and other tissues. These are loaded with a liquid which is often septic to commence with, and will inevitably speedily become so. In such cases as the foregoing antiseptics are not entirely available, as they cannot thoroughly reach the infected areas. What we attempt in these cases, then, is to secure free draining away of septic discharges, and early separation of putrid or infected tissues, and by frequently renewed dressings of an antiseptic nature to prevent the multiplication and virulence of septic germs in the tissues already damaged.

I am very conscious that I have only been able to give a superficial and meagre account of this subject, all-important to patients, to nurses, and to surgeons; but I am hopeful it may present to nurses, in a manner easily understood, the scientific reasons for the practices which form part of their daily duties.

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